The period of the Enhanced Evolutionary Eynthesis (from 1950) (Part 1)

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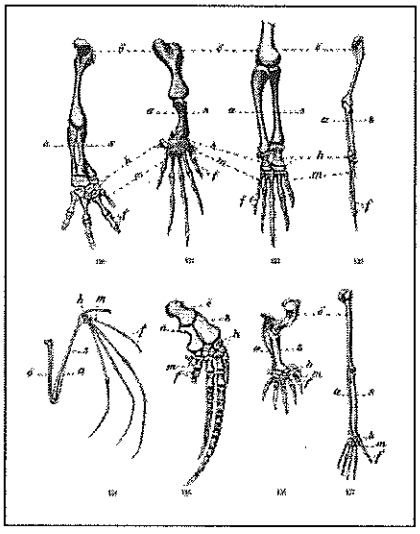
Exercise 1 (home group, individual work):

Read the following text carefully. Your task is to fill in the missing words and phrases, which you know from your biology lessons. If you need help, you can...

- go back in the text **or**
- read further.

If you have problems understanding the text, write down your questions!



The zoologist and marine biologist **Adolf Remane** established in 1952 the three main _____. They are a practical tool for research on phylogenetic relationships because they enable the researcher to differentiate between homologous and analogous traits. Homologies can be used to make inferences about kinship (fig. 1).

Fig. 1: Homologous structures: Front limbs of salamander, turtle, crocodile, bird, bat, whale, mole, human (from left to right). (Wilhelm Leche, 1909; www.wikipedia.org)

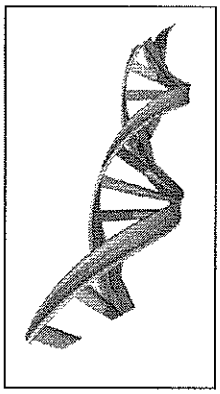


Fig. 3: Structure of DNA. (Courtesy of Apers0n; Source: www.wikipedia.org)

One year later **James Watson** and **Francis Crick** succeeded in clarifying the structure of DNA. At that time, the molecular components were already known. The discovery of the structure of DNA was possible due to the method of X-ray crystallography. Francis Crick was already familiar with this technique because he had investigated protein structures this way. Crick introduced Watson to X-ray crystallography after Watson persuaded him that it is a worthy method for analysing the structure of DNA. A photograph of crystalline DNA

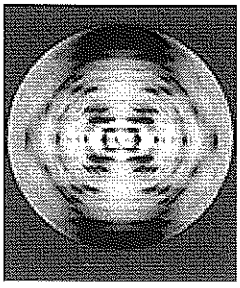


Fig. 2: X-ray photograph of DNA. (Courtesy of the National Institute of Health; Source: www.wikipedia.org)

triggered an important insight (fig. 2). The photo was a result of the research of the X-ray expert Rosalind Franklin, who started her work in 1951 at the same college as Watson and Crick. From the photo, Watson concluded that the shape of a DNA molecule is a _____ (fig. 3). The researcher had seen X-ray photos of other helical molecules before. Subsequently, Watson and Crick reconstructed the exact plan of a DNA molecule with the aid of handmade wire models and finally published the DNA structure in 1953.

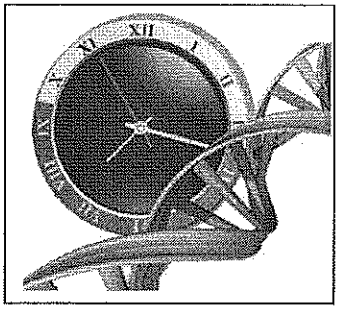


Fig. 4: An illustration of the discovery from Pauling and Zuckerkandl.
(Courtesy of Apers0n and Trojan respectively; Source: www.wikipedia.org)

Linus Pauling and **Emile Zuckerkandl** first postulated the concept of the _____ in 1961. The discovery displays a measuring tool for estimating evolutionary distances. The basis for this concept is the following correlation: The longer two systematic entities are separated, the bigger is the number of differences in nucleotides and changes in amino acids. The molecular clock corresponds with mutation rates of single genes or with differences between sequences in single proteins. This technique cannot be applied in every case, because not all genes or proteins possess a reliable average evolutionary rate. Therefore this method is hardly ever exact. The clock can be adjusted by the fossil record and enables the researcher to estimate e.g. at which time a specific speciation event took place.

Even insights from geology played an important role for developing evolutionary theory further. In 1962, geology was revolutionized by the theory of _____. The theory comprised the movement of plate tectonics and the forces which affect it. Furthermore, the theory explains the distribution of volcanoes, earthquakes, mountains, rock formations and the structures of the sea floor. The formation of these large-scale geological structures can be accounted for by the movement of the tectonic plates. As early as 1915, **Alfred Wegener** postulated the theory of continental drift based on his observation that the continents surrounding the Atlantic fit together like a puzzle. His theory was not accepted at that time because his assumptions on the driving force of plate tectonics proved wrong. Wegener hypothesized the tidal forces of the moon and the sun to cause this movement.

In 1962, **Harry Hess** and **Robert Dietz** found a plausible explanation for the driving force of plate tectonics, which is still accepted today. Hess and Dietz realized that convection (lat. *convehere* = to convey) in the mantle of the earth can passively pull and push the continents (see fig. 5).

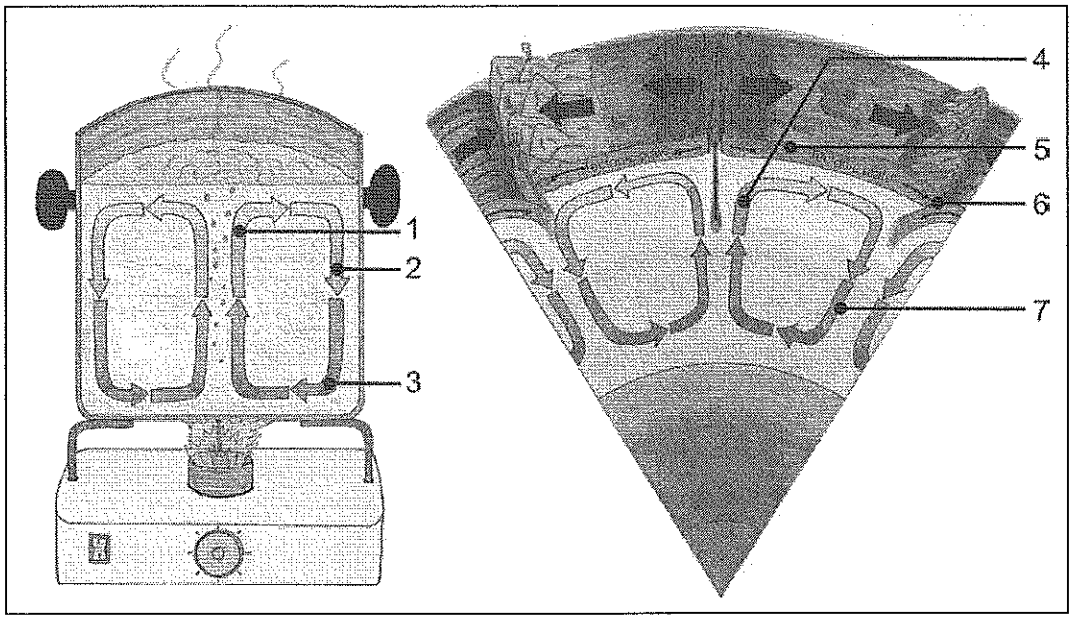


Fig. 5: Convection. A comparison. (The numbering belongs to exercise 2c).

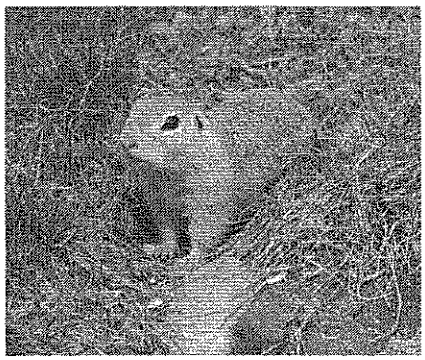


Fig. 6: A Ground Squirrel watches for predators.

Another problem in evolutionary biology was the explanation of altruistic (unselfish) behavior. Already in the 19th century Charles Darwin, the father of evolutionary theory, described leaving (direct) offspring as the highest aim in life for each individual. But he would not have been able to explain, why Belding's Ground Squirrels take a high risk of dying, when they warn other members of their species against predators. The animals utter a shrill warning cry, which does not only inform other members of their species about danger but also informs predators about the position of the alerter. Today it is known that the animals only risk their life when they are surrounded by closely related members of their species. For the relatives the chance of survival is increased enormously by the warning cry.

The behavior of Belding's Ground Squirrel can be explained by the so-called kin selection. In 1964, William Hamilton developed a formula in order to predict under which circumstances unselfish behavior occurs. The basis for the formula and therefore the cause for altruistic behavior were already known in 1964: unselfish behavior depends on the degree of relationship. If the degree of relationship is known, it is possible to decide, if _____ exists or not, due to the Hamilton-formula. Kin selection is a kind of natural selection because it increases the likelihood of passing on one's genes (contains in the close relatives) to the next generation.

Two years later, the zoologist **Willi Hennig** elaborated on the principle of _____, he had first described in 1950. This principle represents an application of Darwin's theory of common descent to the discipline of systematics. Willi Hennig defined systematic groups as groups of organisms which share a common ancestor as well as all descendants of this ancestor. In contrast to this, classical systematics before Hennig often described groups, which did not comprise all descendants of a common ancestor (see fig. 7).

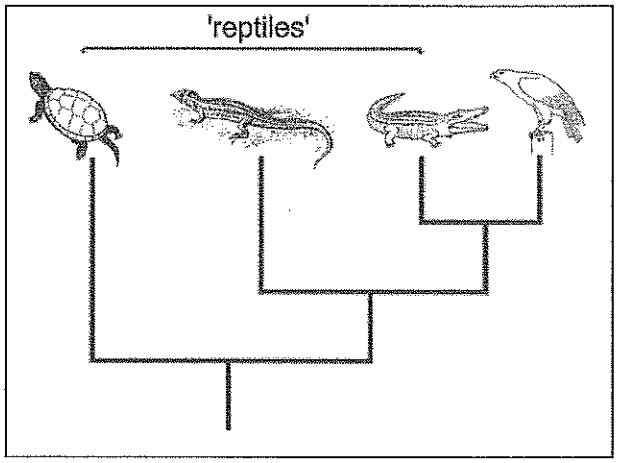


Fig. 7: A cladogram.

Exercise 2 (expert group, teamwork)

Check your cloze texts and your reading comprehension for correctness. Subsequently answer the following questions:

a) Read up on the criteria of homology by Adolf Remane and give one example for each.

b) Specify the components of a DNA molecule.

c) Explain the meaning of convection flow. Thereto, cut the pieces of the sentences on the page 8 and arrange them so that they are in accordance with the numbers in figure 5.

d) Explain why altruistic behavior is finally selfish.

e) Explain by means of figure 7, why reptiles do not exist as a systematic group in phylogenetic systematics.

Exercise 3 (expert group, individual work)

Copy the terms you filled into the gaps of the cloze text (everything that is underlined) onto the 'milestone-cards' (see last page of the material). There is one card for each milestone from the period of the enhanced evolutionary synthesis (part 1).

Exercise 4 (home group, teamwork):

Each of you is asked to present the milestones of his/her period to the other team members by attaching the milestone-cards chronologically to the time bar. The expert for the period of Darwinism starts. For each milestone-card, the expert explains, which person arrived at which insight by which means and how the insight changed evolutionary theory. Afterwards, the next expert follows until the time bar is completed.

Exercise 5 (home group, teamwork):

After completing the time bar, your team creates a concept map with as many connections as possible.

1.) Choose at least 12 milestones from the time bar (each period should be included).

2.) Write down the term from each milestone on a piece of paper.

3.) Arrange the pieces on a blank sheet so that the milestones which have a close connection lie close to each other. Consider what kind of relationship exists between the different milestones.

The following advices my help you:

The relation between two terms can be that …

… one term is an example of the other term (i.e.: mimicry is an example of natural selection).

… one term is part of the other term in the sense of a whole – part relationship (i.e.: chromosomes contain genes).

… terms are superordinate or subordinate concepts (i.e. mutation and selection are evolutionary factors).

4.) If you are satisfied with the arrangement of the milestones and the relations between them, glue the pieces of paper on the blank sheet.

5.) Now draw arrows between the terms.

6.) Describe the relationship above the arrows.

… heats up and moves upward again.

… and submerge in the mantle of the earth, where it melts and the hot melted material moves upward again.

Hot material moves upward from the mantel of the earth …

…and leads to the origin and separation of tectonic plates.

Through convection water moves from the bottom to the surface …

… cools down, moves sideward and sinks down…

Where tectonic plates converge the cooler plate will submerge under the upper one...